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Contents of this number.

INTRODUCTORY NOTICE.

IN submitting **ELEKTRON** to the public, we wish to define our position, so far as it is possible to do so at the commencement of the career of a publication, the course of which we trust will extend over very many years.

We are fortified, by the opinions of those better competent than ourselves to form an impartial judgment, in the belief that there is an opening for an independent magazine which will furnish to its readers unbiassed electrical information and scientific news, as well as cognate articles of a nature apart and distinguished from the influence of financial and speculative operations.

At the present moment we do not believe that any publication actually occupies just this position. Although advertising is at the present date almost a necessity for any enterprise of this nature, and we shall welcome in the proper place all advertisements of a reputable and legitimate character, at the same time we do not intend to be influenced thereby, and we desire it to be understood that we shall entertain no proposition to publish matter in this journal for pay except in the advertising pages.

In our editorial columns we shall publish our own opinions only; those of our patrons who desire to advertise their inventions or apparatus can do so freely in our advertising pages.

It should neverthelesss be recognized that we are at all times willing to receive information and explanations as to any new developments or improvements in the field of electricity, or any subject legitimately connected therewith, and contributions, descriptions, or articles pertaining thereto of suitable nature will be gladly received.

With this explanation, we claim a share of the patronage and attention of the public interested in electrical questions, and assure our readers generally, that no pains or expense shall be spared to make **ELEKTRON** an organ of interest and value, and worthy of their respect and confidence.

THE EDITOR.

Elektron

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ON THE ELECTRO-MAGNETIC THEORY OF LIGHT.

BY A. E. DOLBEAR,

PROFESSOR OF PHYSICS, TUFTS COLLEGE.

It is not a long time ago since the different departments of physical science were treated as being independent branches without any necessary connection with each other. Heat, and light, and electricity, were such before the idea of convertibility had gained recognition, and even then the mechanism by which various forms of energy could be transformed into each other was so dimly seen, that the old terminology was held to.

Thus, for a long time after it was well known that any ether wave could heat a body or do chemical work, physicists continued to talk about heat waves and light waves and actinic waves in a way that implied clearly enough that they had not yet got rid of the idea of different kinds of ether waves. There were dark heat waves and light heat waves, and there were light waves that could not be seen. By and by it began to be taught that light was, after all, a physiological phenomenon that depended upon the kind of structure the ether waves fell on, and then the word light began to be dropped as a proper heading for the phenomena of ether waves, and the section is headed now Radiant Energy; whether seen or not, is merely an accident. Indeed,

there seems to be some probability that the word "light" may drop out of physics very much as the word "force" is dropping out.* This came about largely through the work in spectrum analysis, when it was perceived that gaseous molecules vibrated at definite rates, so that the wave lengths stood in some sort of harmonic ratios to each other, which implied that the molecules were elastic bodies and the waves they produced by their vibrations depended simply upon the molecular pitch, so there was no more reason for calling a short wave by a different name from a longer one than there was for calling a sound wave of a high pitch by another name than that applied to a lower pitch. Now the tables give the number of vibrations per second of the hydrogen molecules that give, say, the *C. F.* and *h.* lines, and although the numbers are very large, some of them thousands of millions of millions, yet no doubt is expressed of their accuracy.

Furthermore, we are also informed that the kind of motion that gives rise to these ether waves is a true vibratory motion of the molecule, not an oscillatory change of position, for such change could not give the precision of wave-lengths actually observed. As it is the heat of the molecules that gives rise to the waves themselves, it follows that what is called heat is the internal vibratory motion, and not the irregular oscillatory motion in free path, either long or short. This is about the same as saying that free-path motions of molecules do not give rise to ether waves of any observed wave length, and we therefore are led to look directly to the internal movements of molecules and atoms for such waves as we have observed.

It has been a notable difficulty to perceive how any kind of a motion of an atom or molecule could possibly produce a wave in the

*In 1880 I called attention in an article published in "Science" to the misleading terminology on light, heat and electricity, and suggested that each form of energy should have a specific name. I suggested, too, that it was a matter of so much importance as to properly be referred to a committee of the American Association for the Advancement of Science. It appeared that others did not feel the need for such a change, and nothing was done. It is with some satisfaction that I see the same subject now being considered in England, and the recommendation made that it be referred to a committee of the British Association.

ether which should have such characteristics as ether waves do have, having their amplitude at right angles to the direction of propagation, impossible in a gaseous or solid medium; but the electro-magnetic theory of light now comes in to help out in this mechanical extremity. This theory is that all ether waves, long or short, are simply due to electro-magnetic stresses somehow set up in the ether, and takes one necessarily back to the molecule or atom as in some way an electro-magnetic body.

Every magnet has its "field," indefinite in extent, the strength of which follows the law of inverse squares. Imagine, then, a straight bar magnet held in the hand. Its field is illimitable—the ether about it is in a magnetic stress, capable of warping a polarized ray of light. Reverse the direction of its poles and the whole field changes throughout the universe. Make such reversals once a second, and this change in the field will travel outwards with the velocity of light, 186,000 miles a second, which will be the length of the wave. If the reversals be made twice a second, the wave will be half as long, and if made ten times a second, one-tenth as long, and so on. One reaches very soon his limiting velocity of moving such a magnet, but let him now take, say, a horse-shoe permanent magnet, and, holding it at the bend, strike it so as to make it ring like a tuning fork. The poles will approach and recede from each other and so will change the strength of the field, and this, too, will be propagated with the same velocity as the others, but the pitch of the magnet will determine the rate at which the wave will be made. The magnet may vibrate a thousand times a second, in which case the wave will be but 186 miles long.

As a body is made smaller and smaller its rate of vibration rises, so that if the magnet was only the dimension of a molecule its rate of vibration would be hundreds of millions per second, and if its elasticity were as much greater than that of steel, as the elasticity of the ether is higher than that of steel, the vibratory rate would be comparable with that of molecules as we find them to be. In such a case we have ether waves that travel outwardly with the velocity of light due to changes of

stress in a magnetic field already present, instead of the other idea of a series of waves in a medium without initiatory stress. There is this assumption, however, namely, that the atoms of all kinds of matter are themselves magnets, and it hardly needs to be said that there is very much reason for thinking this to be the case. The molecules of ordinary matter as we examine it are nearly if not quite all compound, and some of them quite complex. Magnetic fields may overlap each other, but not to efface each other—there may be equilibrium with any amount of stress. In a piece of iron subject to a helical current of electricity, the molecules are merely made to face one way—they do not themselves become magnetic, they are already endowed and have their individual fields as extensive as space, and it is not apparent how any condition could destroy the field of any one, so that combinations of any sort might so make fields to overlap that they could not be identified, yet without in any way destroying the grip that every atom has on the whole of space.

The above considerations make it much easier to understand how waves in the ether are set up, whether they be long or short, and whether they be called light or any other name. They also make plain what is meant by the electro-magnetic theory of light.

ELECTRICAL DEVELOPMENTS IN THE FAR WEST.

The developments in electrical directions in the Far West are becoming daily of more and more importance, of more importance, indeed, than is realized in the East.

The principal item of discussion and interest at present before the electrical people out there is that of the California Mid-Winter International Exposition. It will be a much larger affair than was originally anticipated, and will undoubtedly exceed in scope and interest the Philadelphia Exposition of 1876. An idea of its size may be gained by the statement that there are over eighty different separate buildings now in course of completion. The main building, that of the Manufactures and Liberal Arts, is nearly as large as the main building of the Centennial Exposition. There are three other buildings nearly approaching this in size, those of the Mechanical Arts, Horticulture, and the Festival Hall.

The Fair is located in one of the most beautiful parks in this country —the Golden Gate Park of San Francisco.

In its electrical features, it will show most of the interesting exhibits of the Columbian Exposition, with many other matters in addition, having a direct bearing on subjects of local attraction.

It is well known, of course, that the State of California furnishes the most perfect opportunity for the installation and use of water power plants upon a large scale. The western trend of the Sierra Nevada abounds in ample water supply, free from ice and snow, and with enormous falls, giving almost incalculable quantities of power. These powers are mostly located at distances varying from twenty to a hundred miles from the places where the demand for power exists. Coal averages in price from $7 to $10 per ton, and is almost wholly bituminous. It can therefore be readily seen what an immense field for power transmission, and especially electrical power transmission, exists. This

feature will be presented at the Mid-Winter Fair in quite an extensive way by several companies interested in this class of work.

Another prominent part of the electrical exhibit will be devoted to the use of electricity in mines and mining work. It is proposed to construct a regular operative mine showing all the different apparatus in use. This, of course, will make a very interesting feature.

As an idea of the extent to which electricity will be used at the Fair, it may be stated that the number of incandescent lights called for exceeds 25,000 16-candle-power lamps, and the number of arcs about 1,250.

The companies consolidated under the Edison interest have the largest power and lighting plant in the State of California. They are prepared now from their three stations in San Francisco to supply about 50,000 incandescent lights and 4,000 arc lights. The Los Angeles company is supplying about 750 arc lights and 5,000 incandescents. There are also large stations in Oakland, Sacramento, San José, and Stockton.

A three-phase power transmission plant has been during the course of the past year installed at Redlands, Cal., by the General Electric Company, and is claimed to be the first commercially operative plant of the kind in the United States. We are indebted to the pages of the *Electrical Review* for some interesting details in connection with the installation:

"Two 250 kilowatt, ten-pole, three-phase generators, delivering current directly to the lines at 2,500 volts between lines; two D-10 exciters, each capable of energizing the fields of both generators, and one 50-light, 2,000-candle-power Thomson-Houston arc dynamo. With the stream at its lowest, 800 horse power is developed at the generators. Room is left and foundations are in place for a third three-phase generator and a second similar arc machine. The large generators run at 600 revolutions, give 6,000 alternations per minute, and have a rated output of 100 ampères at 2,500 volts. To each of these large machines a Pelton wheel is directly coupled, the three-

phase generators being supplied with 200 horse-power double wheels, each operated by a double nozzle.

"The regulation of the hydraulic power is by the ordinary differential nozzle operated by Pelton differential governors driven from one of the exciter shafts. A second small differential governor, driven from the other exciter shaft, steadies the action of the first by regulating the exciter wheels. Either machine can be thrown on either circuit, and both machines in parallel on either or both circuits. At present the parallel connection is chiefly used in shifting over the load to obtain perfect continuity of service. A six-ton travelling crane permits ready handling of any of the machinery.

"From the power house are run two three-phase circuits, each composed of three 00 B. & S. wires. One of these runs to the company's office at Redlands, a distance of seven and a half miles, and from thence is distributed over the city for lighting and power purposes. On a substantially built pole line the other extends to Mentone, four and a half miles, where is located the artificial ice plant of the Union Ice Company.

"In this plant is installed a self-starting 150 kilowatt, triphase, 750 revolution, 6,000 alternation, synchronous motor, belted through the medium of a countershaft to two large compressors for the ammonia, a circulating pump for the compressor jackets, a force pump to supply water for the ice, and a small elevator for handling the ice. In order to ascertain the point of synchronism, a Thomson acoustic synchronizer is employed, and gives unqualified success.

"The transformers used are very similar to the ordinary General Electric Type F transformer, except that they are designed for 50 cycles per second and to reduce the pressure from 2,200 to 110 volts. So far as possible rather large transformers are used with comparatively long secondaries."

It is stated that so far no trouble whatever has been experienced from any unbalancing of the lighting lines.

Another transmission plant has been in operation for nearly a year,

the plant being located at San Antonio Canon, and delivering light to the towns of Pomona, Riverside, Colton and San Bernardino, and other smaller places, the farthest point in single distance being forty-eight miles from the source of power. Another transmission plant amounting to about 3,000 horse-power is being installed at Folsom, a distance of eighteen miles from Sacramento. These are some of the prominent instances of practical work now going on or being installed.

We anticipate in the near future some interesting information from this part of the country, which is developing quite rapidly, although not so much so as would be the case in the absence of excessive freight rates and the lack of cheap fuel and iron. With the impulse of the Mid-Winter Fair, the fact that there have been few or no bank failures there, and the reviving tendency of capitalists to go ahead with new projects, there seems little doubt, however, but that a brilliant future awaits the Far West.

THE BUOY LIGHTING OF THE WATER-WAY TO THE WORLD'S FAIR.

BY COMMANDER J. J. BRICE, U. S. N.,

INSPECTOR NINTH LIGHTHOUSE DISTRICT, CHICAGO.

The establishment of the electric buoy lights as a fair-way, marking the channel from Van Buren Street Wharf, Chicago, to the Casino Wharf at the World's Fair, commenced May 1st, 1893, in the preliminary work, by placing ordinary spar buoys to mark the line of electric lights.

The plan at the foot of this article, for locating the buoys, was carried out, and consisted of thirteen cedar buoys of different sizes adapted to the depth of water, which ranged from nineteen to thirty feet. The buoys were half a mile apart, commencing one-half mile from the Casino Wharf, and running in a line passing half way between the outer and inner Hyde Park Shoals, a mile and three-quarters from shore at the farthest point. Between these shoals they turned at an angle, and ran in the direction of Van Buren Street Wharf, the last, or thirteenth buoy, being located one-half mile south of the Chicago South Breakwater.

The buoy is of cedar, with a cavity in the side large enough to admit two parts of the cable and allow a batten to fit snugly over after the splices are made. The cable enters the buoy about three feet from the heel and passes up its entire length to the lamp in a groove or slot cut in its side for the purpose. The buoys are anchored with iron sinkers. There is also an iron ring fitted in the eye of the strap on the buoy, which is used only for lowering the buoy into place by means of a sliprope. A scow was used, on which the buoys were fitted and the splices made, and when completed hoisted from the scow and lowered into place by the derrick of the lighthouse tender.

The cable used was manufactured by the Bishop Gutta-Percha Company of New York, and is composed of seven strands of No. 16

copper wire, B. & S. gauge, with one-quarter inch gutta percha insulation, protected by a jute bed of one-half inch, and armored by No. 8 galvanized iron wire, wrapped around spirally.

The cable attached to the buoys came in lengths of a little more than half a mile each, made up on thirteen different reels, and the main cable on three separate reels, covering the distance of seven miles. All of the cables were reeled off from a scow towed from buoy to buoy, the main cable being laid direct from the thirteenth buoy to the Casino Wharf, outside or off shore from the buoy, to prevent its drifting inshore.

The original plan to light the electric buoys between Chicago and the World's Fair was with an alternating current, the power to be taken from the World's Fair plant. A special converter or transformer was made to reduce the current from the World's Fair circuit of 2,000 volts down to 1,450 volts. Special shunt coils in series were used with the cable, secondary terminal of which was connected with the lamp. On testing the cable, although the electro motive force was 1,450 volts, the current reading showed only 1.5 ampères going into the lamp, the capacity of the lamp at the time being 5.2 ampères for normal candle power. The pressure was then increased to 3,300 volts, the current-reading then showing only 1.2 ampères even with this increased force.

The conclusion arrived at from these unexpected peculiarities, and the failure of the system to operate successfully, is supposed to be the fault of the spiral-armored cable. It has been maintained by skilful electricians that the spiral armor acted as a condenser, and that induction so great took place that the working force was lost. The lamps used at this trial were especially made of 100 candle power and 5.2 ampères, 100 volt Edison lamps.

After the trial and failure of the alternating system, the lamps and connections were changed to an arc or direct series system. The Edison lamps and shunt coils were removed from the head of the buoys, and a Bernstein lamp of 100 candle power and 10 ampères substituted, and an electric percussion-cap fuse introduced for continuing the

uninterrupted current to the other lamps, in case of accident to the filament of a particular lamp. This fusible plug fits into a socket for which the Bernstein lamp is fitted, and closes the circuit when the filament breaks; this is accomplished by the percussion-cap exploding when the current is forced through it by the destruction of the carbon filament, thus allowing the current to pass to the other lamps through this new channel.

The buoys were lighted from the 1st of July to the 30th of October by the direct current, and worked satisfactorily and without accident of any kind, with a visibility of seven miles. No difficulty was experienced with this mode of lighting, and the only objection to the direct current for submarine work is that the cable is in direct circuit with the dynamo, consequently danger to the apparatus and to life is somewhat increased by the possibility of ground contacts.

But two lights went out during the time—from destruction of the filament—and in neither case were the lights interrupted in the other buoys, showing that the fusible cap filled all requirements. The buoys involved little or no care, and but slight expense; and upon the whole, the system worked with entire satisfaction.

The lighted fair-way from Chicago to the World's Fair, through somewhat dangerous shoals, did away with all danger of accident by collision or running upon reefs. In fact, the channel was as well pointed out as the pathway in the streets, calling forth expressions of admiration and satisfaction from the community for this new departure in lighting up the waters.

"*AS OTHERS SEE US.*"

By PROF. S. P. THOMPSON.

FROM THE "ELECTRICIAN," LONDON.

One who sits down to review the proceedings of the Chicago Congress of 1893, and to draw an estimate of the work it may have accomplished for the advancement of electrical interests, finds himself involuntarily framing comparisons with the congresses that have preceded it. Yet if he would rightly estimate its operations at their value, he must, at least, attempt to dissociate himself from such comparisons. For, in fact, each congress is individual, not in reality bound by the decisions of any that have preceded it, and possessing no power to bind its successors. Each congress has possessed distinctive features of its own, and that of Chicago, now just closed, is no exception. The location, the attendent circumstances, and the internal arrangements, all differed from those of previous congresses. To begin with, it was the first and only international electrical congress held on American soil. Electrical congresses and conventions of purely local or only national scope have been held from time to time in recent years in the United States and in Canada. But at such gatherings the presence of a foreigner has been an 'unusual circumstance, and comparatively little importance has attached itself to any discussion or decision made. In the present case not only were many Europeans present, but the number of electricians from America itself exceeded that at any of the preceding gatherings in the States. And the congress itself received an indefinable sense of importance to Americans from the circumstance that its decisions would, in some way, bind and commit the American nation on certain questions hitherto open.

The situation in the States of such matters as the decision of a congress might affect is somewhat as follows: In the International Congress, held in Paris in 1881 and 1884, America was represented.

Her representatives in the former year accepted the main decision then arrived at, to adopt for international purposes the British Association system of units, as modified by the addition of the names of the "coulomb" and the "ampère," and with the substitution of the mercurial column for the old British Association unit as the standard of resistance. But in 1884, when it was agreed to accept for the length of the mercurial column representing the ohm, the figure of 106 centimetres, the American representatives had been amongst the dissentients, holding that a nearer approximation to the true ohm would be made by an addition of two or three millimetres. How completely they were justified subsequent events proved. But, from that day to the present, the so-called legal ohm (with the corresponding volt and farad) had never been recognized by the United States Government, which had taken no steps to legalize any electrical units or standards. This is the more remarkable when it is remembered that last year the United States adopted as the legal standards of length and mass in America the actual "mêtre des archives" and the "kilogramme" now deposited at Paris at the International Bureau of Weights and Measures. Beyond question, the leading electricians of America were prepared to act in concert with European nations. They had watched approvingly how at Frankfort the ohm of 106.3 centimetres was preferred to the legal ohm of 106. They had cognizance of the careful and anxious examination made by the British Board of Trade. They knew how at Edinburgh, in 1892, at the suggestion of Von Helmholtz, the definition of the ohm had been modified so as to express the standard column of mercury in terms of mass instead of those of cross section. All this facilitated decision, and rendered concerted action more easy. There being no governmental telegraphs in the States, no official interference could prejudice the decisions of the congress or balk the electricians of America from accepting them.

Beside the main question of securing international agreement on the fundamental units and standards, there were a few other topics of American interest. There was the proposal to christen the unit of

self-induction as the "henry" in honor of Joseph Henry, its discoverer. There was a suggestion to advise on legislation as to the proper way of describing the candle power of an electric lamp. There were proposals to name a set of magnetic standards; to settle an international notation of electrical quantities, and to decide on a practical unit or standard of light. Such was the official programme before the congress, but the unofficial programme was a much wider one. A very extensive list of suitable topics had been circulated many months beforehand, and papers invited from numerous leading electricians. Keen debates were expected upon the burning topics of the day, and several of the papers promised were avowedly written to promote discussion.

Like the congresses of 1881 and 1884, but unlike those of 1889 and 1891, which were of an unofficial character, the congress of 1893 comprised an inner Chamber of Delegates, consisting of the official representatives of the several governments. It will be remembered that in 1881 the French government appointed no fewer than 75 French delegates in a chamber consisting of little more than 100 members. In the present case the United States Government appointed only five, and allotted an equal number to the three great powers, England, Germany, and France, other nations having fewer. The chamber sat with closed doors, but admitted by invitation as visitors, without voting power, a few electricians, mostly German and American, whose knowledge of the subject of units rendered their presence of special value.

The congress at large had, as acting chairman, Dr. Elisha Gray of Chicago, so well known for his pioneer work in telephony and harmonic telegraphy, and lately for his telautograph. At its first assembling it elected by acclamation as honorary president his Excellency Dr. von Helmholtz. It has also as presidents of its three sections Prof. Rowland, Prof. Cross, and Prof. Houston. Its general secretary was Prof. Crocker, who, unfortunately, was only so chosen after the meeting of the congress. Had he been appointed beforehand much

valuable time that was wasted on preliminary arrangements would have been saved.

And here a word of explanation as to the loose character of the arrangements made for the accommodation of the congress may be recorded. Had the electrical men of the States held the control of affairs, no doubt the whole, from first to last, would have been carried through in a business-like way, with efficiency, and dispatch, and method. But, unfortunately, since the congress was supposed to be in some way connected with the World's Fair, the work of preliminary preparation was committed to a semi-official organization known as the World's Fair Congress Auxiliary, presided over by an utterly incompetent and fussy official of the name of Bonney, who sought to magnify his office by calling together in Chicago no fewer than 150 different congresses on all topics, from religion to piano tuning. Of these there was a large number going on every week, the Electrical Congress week witnessing also Congresses on Astronomy, Spiritualism, Africa, Chemistry and Freemasonary. Persons accustomed to the good organization of the meetings of the British Association were horrified to find conspicuous by their absence all such features as the daily programme, the reception room, the printed list of members, and the like. The list of papers to be read (not in their order), though prepared on the Friday evening for the press, was not ready for distribution till Tuesday. The rooms chosen both for the general session and the section meetings were intolerably noisy, opening upon a busy station of the Illinois Central railroad. And no provision was made for securing proper reports. The daily newspapers of Chicago city made no efforts to give useful reports, and sent reporters destitute of any technical competency, who merely chronicled trivial personalities. On the other hand, great efforts were made by the proprietors of three leading technical electrical journals to produce reports of the congress with promptness. Such alertness on their part made the incapacity of the daily papers seem even more glaring. This congress, the only official one of all the series, was treated as though it had no more

significance than a congress on chess playing. It was entirely ignored by the municipality, and by the prominent citizens of Chicago. If it had not been for the personal exertions of Dr. Elisha Gray, Prof. Carhart, and some of the more active members of the American Institute of Electrical Engineers, who at an early date took an active part in foreshadowing the arragements to be made, the whole thing would have been a melancholy fiasco. Englishmen, knowing the difficulties which their American brethren may have to meet from the incompetence of officials who owe their appointments to political influences, can make allowances. What their continental brethren may have thought of such a discreditable state of things may be imagined.

After the opening session of the general congress, with its speeches of welcome, sectional meetings were held. Section A, on topics of theory under Prof. Rowland, met next morning only to adjourn, being unable for that day to discover what business there might be for it to transact. Sections B and C, which were respectively devoted to mixed theory and pure practice, were more fortunate, and held active sessions each morning, and were attended by considerable numbers. The chief discussions, some of which had to be adjourned, were on the subjects of Long-Distance Transmission of Power, Multiphase Motors, Phenomena of the Arc, and Ocean Telephony. Prof. Ayrton's paper on the arc will probably be the most enduring in note of all the papers read. Mr. Preece's account of his experiments on telegraphing without wires was also well received.

The Chamber of Delegates, under the presidency of Prof. Rowland of Baltimore, met usually in the afternoons. It set to work first upon ratifying the fundamental electrical units in such form as to meet with international agreement. There was a little dissension as to the actual end to be arrived at, but much discussion as to the form. After it had been agreed to adopt as the international standard of resistance the mercury column ohm 106.3 centimetres in length, there arose a prolonged wrangle as to whether this should be taken as a primary

standard or not. Prof. Mascart desired that this material standard should be decreed to be the ohm without any reference to the centimetre-gramme-second system of units from which it is supposed to be derived; just as the international meter is defined as a certain bar of platinum without reference to its supposed relation to the quadrant of the earth's meridianal circumference. On the other hand, Prof. Mendenhall strongly urged that the abstract definition as 10^9 in the C.G.S. system should be retained.

Eventually, by the appointment of a small sub-committee to settle the wording, a compromise was arrived at, which leaves the definition in entire accordance with that already accepted in England, Germany, and France. Similarly, with the definitions of the ampère and the volt, compromises were finally voted with unanimity. It was curious to note that M. Mascart, who had stood out on the ohm as the champion of the material standard, advocated equally succinctly the definition of the ampère as an abstract unit without reference to any material way of reproducing it, whether by silver deposit or by some standard gravitational ampère-meter or electro-dynamometer. M. Mascart denied the precision of the silver deposit, and was supported by his Excellency von Helmholtz. Professors Carhart and Rowland equally impugned the possibility of getting an absolute reading correct to one part in 10,000 by either electro-dynamometer or by tangent galvanometer, unless in some special research of extraordinary precision. Then the question was raised whether, supposing the ampère should be defined only in terms of the ohm and volt, the latter could be more accurately defined in terms of absolute value than the ampère could be. It was urged that Clark's cells could be made easily to agree to within one part in 10,000 to one another. On the other hand, it was doubted whether the absolute value of the cells so agreeing with one another was determined with anything like that accuracy. It was pointed out that the congress of 1881 defined first the ohm, then the volt, and took the ampère as the mere sequence of these two. Was it well now to reverse the order, and define the ohm and then the

ampère, leaving the volt to be defined in terms of that pair of units? Of course, in the abstract relations of the C. G. S. system the order was immaterial; but M. Mascart's proposition was to define the ohm in the concrete and the ampère in the abstract, which would necessitate a definition of the volt as that electromotive force which would send the abstract ampère through the concrete ohm. Eventually these matters were referred, as the ohm had been, to the small sub-committee to frame language, and its report, moved by Prof. Mendenhall, and seconded by Dr. Budde, was unanimously adopted. It defines each of the units as an abstract quantity, but adds in each case the practical standard by which in the present state of science the unit may be sufficiently closely represented for legal purposes. To distinguish these units, as now defined, from the definitions given by previous meetings or congresses, they are denominated the "international" ohm, the "international" ampère, etc.

The wording of the schedules, in which are to be described the details of the processes of silver deposit for the ampère, and of construction of Clark's cells, was relegated to a sub-committee consisting of Prof. von Helmholtz, Prof. Carhart, and Prof. Ayrton. The definitions of the farad, the coulomb, the joule, and the watt were accepted without much debate as the logical consequence of the three units first decided. Over the proposal to recognize the "henry" as the unit of self-induction there was much discussion. Everybody appeared to be willing to agree to the proposal to adopt the name of "henry" (in honor of Prof. Joseph Henry) in place of the impersonal (and incorrect) name of "quadrant," selected by the congress of 1889; but no one seemed to be quite ready to define the quantity to which the name was to be attached. It was pointed out that mutual induction must be expressed in terms of the same unit as self-induction. Eventually, an understanding was arrived at. M. Mascart moved, and Prof. Ayrton seconded, the adoption of the name "henry," whilst the exact definition was referred to the sub-committee. The new definition of induction cleverly turns the difficulty that is involved in any

attempt to take into account the magnetic properties of the medium and reconciles the two opposing views.

Then came up for discussion the question of the proposed magnetic units. Should the C. G. S. system simply be adopted? Or should a "practical" magnetic system be approved having the 10^8 as a factor in it to correspond to the volt? And what should be the names given to such units? Prof. Rowland objected to any extension of the "practical" system, with its eighth and ninth power exponents, into the magnetic part of the subject, urging as one reason that the designers of electro-magnetic apparatus do not use anything except the C. G. S. system. He also objected to multiplicity of names. Some attempt was made to secure the adoption of the name of "gauss" for the C. G. S. unit of magnetic field, it being alleged that for want of some such name incorrect designations were sometimes given; as, for example, where the horizontal component of the earth's field is described as being 0.18 *dyne*. A majority of the delegates failed to see the force of this argument. It was moved by Mr. Siemens, and seconded by Prof. Nichols, that the C. G. S. units of magnetism be adopted without names, and this was carried.

The question of the scientific designation of the brightness of electric lamps was then introduced. What was a 1,000 candle power lamp? Was it one that only measured 1,000 in one particular direction? It appeared that certain American contractors, not of the first rank, had been in the habit of describing a certain kind of arc lamp as of 1,000 candle power, which, in fact, was far from being such. The law being apparently powerless to deal with such frauds in the absence of any recognized definition of candle power, decision was asked on the point. It was suggested that lamps should be defined in terms of watts, not of candle-power. American delegates protested that this would not protect the consumer from having imposed upon him an inferior lamp, which, for the same number of watts, gave less candle power. It was pointed out that under the British electric lighting acts the undertaker cannot prescribe to the consumer what sort of lamp he

must use, and leaves the consumer free to use any lamp that is adapted to the declared pressure or current. It was eventually decided that the difficulty being a purely national, and not an international one, arising mainly out of the circumstance that American municipalities have not yet adopted the wholesome practice of calling in some responsible consulting engineer to advise them upon the terms in which their contracts should be drawn up, the congress could not interfere. But the discussion served to emphasize the uncertainties which exist in the absence of working methods of measuring color and of a suitable integrating photometer.

To other questions, which were referred by the chamber to the sub-committees, received anxious consideration, and were keenly discussed before being reported upon. One of these was the proposal for a system of uniform notation; the other related to the standard of light. The array of symbols proposed by M. Hospitalier was championed by him with ability and eagerness, and was, with some amendments, adopted by the sub-committee, and received by the chamber (but not for official adoption), and ordered to be printed. Some of its details seem open to severe criticism, but if only they could be universally adopted how convenient they would be!

The proposal of Dr. Budde and Dr. Lummer to adopt as a standard of light the Von Hefner lamp, with its reddish flame of acetate of amyl, was no less emphatically urged. There was no other practical lamp of equal constancy—within 2 per cent—and the molten platinum standard was not realizable; then why not adopt it as the standard? It required much backbone on the part of the English, French, and Swiss representatives to resist the vehement plea. But with the possibility of a simple and better electric standard looming in the near distance, giving a really white light of fixed brightness as a standard, it was clear that no proposal for a flame standard would be acceptable, and certainly not this amyl-acetate flame, however excellent may have been the results obtained at the Reichsanstalt. And so the sub-committee, under the presidency of M. Violle, arrived at the inconsequent conclusion that

they were not able to report in favor of any standard at present. All too soon the five days of the congress came to their end, and the final meeting was held to announce the decisions arrived at, and to thank our American hosts for the courtesy and hospitality with which they had received their guests. Dr. Elisha Gray, in finally responding with characteristic simple dignity, thanked all members present for their help, and begged those who came from foreign shores to Chicago not to think only of its smoke and noise and tall buildings, but of warm hearts praying that they might have smooth seas and a warm welcome home.

And so with the inevitable accessories of photographs of groups, of a festive banquet, of a reception by the British Commission, of midnight speeches at the electricity building, and of newspaper portraits mainly of celebrities who never came near the meetings, the Chicago Congress vanished into the past.

GROUND RETURNS FOR ELECTRIC RAILROADS.

BY THOS. J. McTIGHE, PH. D.

When one considers the vast amount of capital which has been invested in electric street railways in a few short years, and studies the various methods of construction, one encounters a most anomalous feature, namely, the return circuit. We see a system which draws forth our honest expression of admiration for its splendid design and painstaking execution. Heavy rails, solid road bed, sturdy steel poles, overhead work of the neatest appearance, yet of great strength and durability, a generating plant where nothing has been forgotten, and every throbbing cylinder, straining belt, humming commutator, and every little lump of coal, lift their chromatic tones in a grand pæan celebrating their united and perfect economy. Every foot of that splendid network of feeders has been calculated to a nicety to exactly fit a predetermined loss of potential. Copper, and the best of copper, has been hung with a lavish hand. Cross feeds are plentiful, section insulators frequent, and altogether the impression is given that surely here is a model system in every detail, and that certainly the average loss of potential in overcoming circuit resistances cannot be more than three per cent. Apparently, every contingency has been provided for.

But has it, in reality? Generally speaking, no. Even Achilles, with all his impregnability, had a heel which gave him much anxiety, and eventually caused his downfall. So in the average electric railway there is one weak and vulnerable feature, the return circuit. Thousands of dollars are spent in gaining a slight increase in the efficiency of the power plant, thousands more in securing a reasonable durability of track and road bed, all with the best of reasons. But the poor return circuit seems to suffer almost universal neglect, or, if not neglected, it meets with a vast deal of trifling. There are plenty of

intelligent men to-day engaged in the construction or operation of electric railways who insist that an iron rail-bond is the only kind that will last, and never think of the real question, which is the total conductivity of the return circuit as a whole. They put in ground plates at intervals, or, worse yet, connect the tracks to water and gas mains at various points. The actual resistance is not figured. Yet it is hardly a more complex problem than that for the feeders overhead. One constructor will advocate plenty of ground wire supplementary to the tracks, another stands for frequent ground-plates or rods, and a big earth plate at the generators, and yet another says copper in the ground is worthless and the only material is iron. And in the interchange of civilities on these absorbing topics the real question of resistance is usually lost sight of.

Many otherwise well-designed electric railway systems in operation to-day have the rails bonded with iron wire less than two-tenths inch in diameter, supplemented by a ground wire of half-inch galvanized iron cable. Others have copper bonds two-tenths inch diameter and a copper supplementary of the same size as the usual trolley-wire. A few careful calculations would show how insufficient all this is under average conditions of traffic and length of line. Bonds thirty, and even forty, inches long are used, regardless of the effect upon the waste of energy. Some of the largest and richest electric railway systems in the land suffer hourly from excessive resistance in the return circuit, and they are paying dearly for the false economy. It might even now pay many of them to take up the paving at every joint of their system, and do the bonding anew.

The earth as a factor in the return circuit in cities and towns should not be considered. It fails in extreme cold weather, because then the rails are in contact with ice, which is hardly the thing to send current through. It is unreliable in good summer weather, because the rails then are in contact with dry sand, which is not much better than ice or frozen ground. And, even if it can, by any process of reasoning, be shown to be a fair and trustworthy conductor for the large current of a city rail-

way, what is the consequence? The current goes directly to the nearest gas or water main, passes from one to the other according to which at any particular point will give it the easier path. At every place where it leaves one for the other the pipe becomes eaten away and sooner or later will give out and require renewal. The electrolysis thus accomplished has necessarily required the expenditure of energy, and energy costs money. This electrolysis has been frequently observed, and it is independent of the direction of the current. Whether positive or negative is placed to line, electrolysis will occur, causing not only a loss of energy and the cost thereof, but the eventual renewal of the water and gas pipes, which costs still more.

The question arises, is there a remedy? There is a practically complete, if not a theoretically perfect, remedy in keeping the return current confined to the rails. This can be done by avoiding all ground-plates, pipes, and supplementary wires and cables, and utilizing to as great an extent as possible the enormous carrying capacity of the average city railway rails. These, jointly, have a splendid conducting power, to utilize which it is only necessary to bond from rail to rail by such means as will at least measurably approach the carrying capacity of the rails themselves. This manifestly cannot be done with iron bonds, but copper bonds can be applied which will come very near accomplishing that purpose. If one bond per joint be insufficient, it is no hardship to apply two, or in extreme cases a heavy copper strap can be applied of such dimensions as will practically make the line of rails electrically continuous. It is often said, and aptly, that the joint in railway rails should be stronger mechanically than the rails, and hundreds of inventions have been launched for the purpose. Cross-sectional area comes into prominence in criticising any given form of joint, and without considering mere form or the strength due to good designing, one would incline to the belief that the sectional area of the joint-plates should at least approach that of the rail. So in electric railway work. An electrical engineer having a long line of bus-bars to erect, would be severely condemned were he to join the successive

sections of one-inch copper bars with bits of wire one-quarter inch in diameter; yet this is just about what is ordinarily done in the track circuit, when a splendid seventy or eighty-pound rail is electrically connected to its neighbors with a paltry No. 4 wire. As above stated, this is wrong, and can and should be remedied. Give the connection from rail to rail plenty of conductivity. The relatively small amount of copper necessary costs but little, and one can afford to be very liberal at this point. A seven-sixteenths or half-inch copper bond, or two of them for heavy traffic, can be applied at less cost than the usual supplementary system, and the results will be found most striking.

Then at once all troubles from electrolysis disappear, and the saving in otherwise wasted energy will pay for the heavy bonding twice over, long before the copper can corrode to any serious extent, since the leading cause of its corrosion—electrolysis—will be absent. We thus get back to the coal pile, and it seems a necessary deduction that in the long run greater economy of fuel is returned for a liberal expenditure in rail bonding, rather than in striving after an over-refined perfection of power plant.

THE WISDOM OF IGNORANCE.

By C. C. HASKINS,

Electrical Insurance Inspector, Chicago.

It has always been conceded, if we may place reliance upon the old saw which defined a Jack-of-all-trades as a good-for-none, that to understand any calling sufficiently to practise it for a livelihood a certain amount of study and attention to the rules and philosophy, the chemistry, or the mechanical peculiarities of the trade or calling which was to be learned were necessary before a full-fledged journeyman was born. Many of the highest names on the roll of fame are those of men who served their seven years' apprenticeship, with all that is implied by that term, including playing groom to the horse, wood-cutter for the kitchen, errand boy for the mistress, and general drudge for the shop,

> " But the trade was well learned,
> And the right was well earned,
> To be a bold journeyman tailor,"

as the old song runs.

Now, I trust the reader will not make up his mind that I am going in the first instance to run a-muck against poor, half-taught, so-called electricians and their miserable construction. I may get around to that by and by, but not in the first tilt. They have much to be responsible for, but let us start in a little farther back, and see if some one else may not deserve a rap over the knuckles, as well as they, for the wisdom of their ignorance.

The cheap architect? Yes; thank you, for the suggestion. I see you are acquainted with him. He is an adept at color drawings, and can make you a beautiful landscape, house and yard with roses and gravel walks, and papa coming home from the depot with lots of bundles, and all that sort of frills; and when it comes to the plan of the house, and you look over the specifications, aside from brick, stone,

mortar and lumber, he is as much off his reckoning as a sailor would be on the Rocky Mountains in the dark. He is particularly and strangely ignorant of everything pertaining to electrical appliances, rules and requirements, and this want of knowledge is so visible in every line of the specifications that deplorable results have often followed the installation of his plants. A cheap grade of material is cheaply put up, the contractor being obliged, by reason of securing the contract at too low a figure, to make up for his legitimate losses by this method of recouping. I have never known a case where a "divide" on profits between the contractor and the architect decided the award, although such a thing may have happened—perhaps it has.

It is very certain that, as a rule, a cheap architect is not necessarily a first-class constructor of electrical work, theoretically or practically. This is true, however: In very many of the houses made after his pretty designs the faults of the installation are never made apparent, for no electrical current ever gets near enough to find a cross, a short circuit, or a ground in the wires.

The fact is that it is necessary nowadays, when erecting a house or a hotel, that it should be wired for electric lights. It's a fad. It rents the house. There are hundreds of recently built tenements of every grade, from the two-story cottage up to grand aggregations of flats in all the large cities, which are so wired, and a higher rental is demanded in consequence. The electric plant is ever in the future, and the cheap architect sees to it also that there are door bells which ring by electricity. It's quite the thing to have a bell which rattles when you push a button. Far better than to have one which jingles when you pull a knob. True, in consequence of the fact of poor wire, and cheap bells with deficient battery, it is necessary every few days to stick a card over the button with this legend upon it: "Bell out of order; please pound on the door," but we must remember it's the style, don't you know.

And the proprietor, the owner, is not entirely blameless, either; somehow or other, everybody seems to think that only a very super-

ficial knowledge is necessary to a perfect understanding of everything pertaining to what has been deemed by some the science of electricity. There are scores of people who are filled with admiration for an engineer electrician, who calls himself an electrical engineer, who would be an expensive luxury at half the wages he is receiving, but he works cheaply, and until an accident or an expert happens along, the wisdom of ignorance is not dispelled.

There is another example found in the profuse electrical inventor. He "gets up" a novelty, and is the fakir of our business. His trick, perhaps, violates all the laws of efficiency, economy, and safety, yet he talks so glibly in the praise of his merchandise as almost to deceive the very elect. Sometimes it is a switch, sometimes a cut-out, or it may be some attachment for bell ringing or door opening, or a lamp socket. He'll invent you anything. To better illustrate this wild sort of scheming let me mention an actual case. A man approached me very cautiously one day with a proposition having millions in it, and he only wanted my indorsement to set the kite flying. He had an automatic door-opener for retail stores. A magnet would withdraw the bolt whenever a person stepped on the metal mat either side of the door. The contact would be made under the person's foot, and the current from the street lamp circuit (say 2,000 V.) would energize the magnet.

Perhaps I was unkind, but I objected to its introduction on these grounds, and in this order:

First—It would have to open and close possibly 25,000 to 30,000 times per day. It would get out of order, perhaps.

Second—As it was arranged to open *from* the person on the mat, what would the poor thing do when two ladies stood glowering at each other through the glass.

Third—If one of them politely stepped off to let the other pass, would it be the proper thing for the lady so accommodated to make the door knock the other lady over for her generosity?

Fourth—How much cheaper (as an inducement) would it be than a boy at $3 per week? And

Lastly—How much would the number of deputy coroners have to be increased to supply the demand it would create?

The wisdom of that chap's ignorance was refreshing.

It is difficult, without becoming personal, to mention instances of electrical appliances which rank with the one mentioned, for economy and usefulness, as well as safety.

There is a practice which in many localities is so universal as to be the rule, rather than the exception, in the installation of plants, for which the constructor is not so much to blame as the powers behind him. It is this: A house or a store is to be wired for incandescent lighting where there are already gas fixtures. The constructor would gladly put in combination fixtures, and probably advises it. "No sir," is the response. "Costs too much money. Wire the outside and insulate from the fixture at the gas nipple." The old fixtures are used. It is a case where you may

> "Call a man a fool and he may brook it,
> But keep your hands out of his breeches pocket."

Now, what has the constructor done? Fastened his flexible cord to the ground at every chandelier.

I once had my attention called to a case of this kind of wisdom, and in the course of the discussion I figured up the number of feet of conductor thus fastened to a dead ground. I asked the constructor if, in case I were wiring a house for him I should fasten over a quarter of a mile of electric light wire to a water pipe or steam coils, if he would accept the job? He replied, in language more emphatic than elegant, that he would not. And yet that was what I showed him he had done with the gas pipe.

It used to be said that it was the easiest thing in the world to be mistaken. I believe it is easier to find fault, but how to correct faults, as Rudyard Kipling would say, is quite another story.

It looks so simple, so easy, to turn a switch and set a machine in almost noiseless movement, or touch a button and open a door, a key and light up a room or throw it instantly into Cimmerian darkness, that it is even too simple to be mysterious. It looks as if anyone could handle it in all its forms, and when it only requires a wire to conduct it, it hardly seems necessary to get an expert to place it. Yet it is a case of monkey and buzz-saw, and there is more wisdom in the saying of one of Dickens' characters than most of mankind are willing to acknowledge:

"Never do anything which it ain't your forte."

A CLOSE SHAVE.

The Edison lamp patent was sustained as valid by competent judicial authority, and it is a question, therefore, not now under discussion whether what Mr. Edison did amounted to the dignity of "invention," as that word is understood in the patent law of the United States. Judge Wallace evidently adopted the view that it did, for in granting an injunction against infringers, he said: "It was a remarkable discovery that an attenuated thread of carbon would possess all the long-sought qualities of a practical burner when maintained in a perfect vacuum. The futility of hoping to maintain a burner *in vacuo* with any permanency had discouraged prior inventors, and Mr. Edison is entitled to the credit of obviating the mechanical difficulties which disheartened them. He made a lamp which was practically operative and successful, the embryo of the best lamps now in commercial use, and but for which the subdivision of the electric light by incandescence would be nothing but the *ignis fatuus* which it was proclaimed to be in 1879 by some of the learned experts who are now witnesses to belittle his achievement and show that it did not rise to the dignity of an invention."

In the course of the vast litigation on this subject an enormous mass of evidence as to the state of the art was presented, with a view of showing, of course, as Judge Wallace says, that the "achievement did not rise to the dignity of an invention."

The following description of a piece of apparatus made by Prof. Crookes, the eminent English scientist, in 1875, is now referred to as showing the extremely delicate division sometimes separating "invention" from mere skill or intelligent mechanical ingenuity. This apparatus, it should be said, was itself a modification of an earlier form somewhat similar in character.

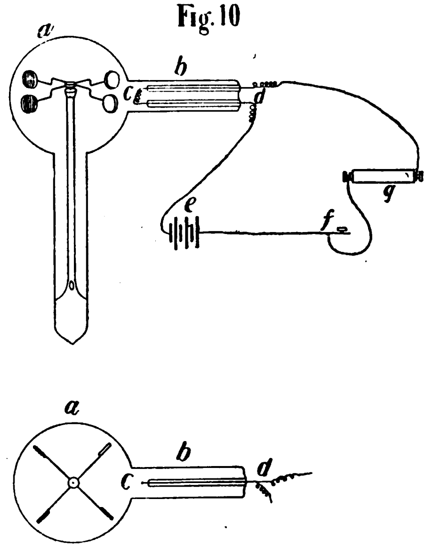
Before considering this device, however, we will quote what Mr. Edison himself claimed as his achievement. It was: "In an electric

lamp, the combination with a hermetically sealed vacuum chamber made entirely of glass, of metallic conductors passing through the glass and around which the glass is melted, and an incandescent conductor placed in the electric circuit, substantially as set forth."

Now, Prof. Crookes' device was not intended for commercial use as a means of producing light by means of heating a continuous conductor within a vacuous transparent chamber. That, however, is what he did, the *purpose* being to illustrate certain effects of repulsion resulting from radiation. As is well known, the investigation of phenomena connected with extremely high vacua and matter in a state of radiant energy is a line of study which Prof. Crookes made peculiarly his own, and to which he devoted years of thought and research.

His own words (Philosophical Transactions, Vol. 166, Pt. II, p. 351, January, 1876), are: "Fig. 10 shows the instrument: *a* is the bulb of a radiator of the usual construction, having pith discs blacked on one side. *b* is a tube sealed into one side of the bulb, and having two stout platinum wires passing along it, sealed their whole length in glass to prevent leakage of air into the interior of the apparatus. At the ends *c* of the wires, a spiral of fine platinum wire is fastened, and the other ends (*d*) terminate in loops outside. *e* is a battery, *f* a contact key, and *g* a resistance coil, which I can vary at will. The bulb was perfectly exhausted and the following experiments were tried:—176. The resistance-coil was so adjusted that the battery would keep the platinum spiral (*c*) at a bright red heat." etc., etc.

Fig. 10



Now, here we have the hermetically sealed vacuum chamber made entirely of glass, the metallic conductors passing through the glass, and around which the glass is melted, and an incandescent conductor in the electric circuit—and inside the vacuum chamber too.

The unexpressed implications appear to be important. A person of a critical habit of mind might suggest that an "implication" is, of necessity, unexpressed. Perhaps so, but the bull, if it is one, expresses what we mean to express.

This is, briefly, that the *claims* are in many cases as unlike the essential invention covered by a patent, as the newly-born child is unlike the youth of 16, and that the real *motif* of an invention is very frequently, possibly too frequently, to be grasped more or less definitely rather from the circumambient ether or *ab externis*, in the form of the state of the art, than from the phraseology of the letters patent themselves.

The *essential* feature of the invention made by Mr. Edison, we are told on good authority, was that of the *carbon* incandescent conductor, filamentary in form, the other devices or elements being ancillary thereto. We believe, however, that in a *combination* patent one star (or element) does not differ from another in glory. Be this as it may, the substitutibility (to coin a word) of carbon for platinum, for this purpose, was well recognized, and the necessity for high resistance had been pointed out by Lane-Fox, if not by others.

In these remarks we are not belittling the achievement of Mr. Edison, which was one entitling him to the utmost credit, but to point out, *pour encourager les autres*, the very fine division between mere mechanical improvement or skill, and the elusive entity called "invention."

THE NEW INTERNATIONAL UNITS.

The following are the new determinations of electrical units, as recommended by the delegates of the International Congress of Electricians, held during the World's Fair in Chicago, to their several governments.

The most authoritative set of units at present in existence is that of the 1884 Paris Congress, but now it may probably be assumed that, even in anticipation of the formal legal adoption by the various countries of the recommendations of their representatives (necessarily a matter of some little time), the new evaluation will be universally employed.

Probably the most noticeable alteration will be the adoption of the undoubtedly more correct 106.3 centimetres, as the length of the mercury column for the ohm, and the expression of the column itself in terms of its mass rather than of its cross section, though the reader will, of course, observe other changes. The report recommends:

"As a unit of Resistance, the International Ohm, which is based upon the ohm equal to 10^9 units of resistance of the C. G. S. system of electro-magnetic units, and is represented by the resistance offered to an unvarying electric current by a column of mercury at the temperature of melting ice, 14.4521 grammes in mass, of a constant cross-sectional area and of the length of 106.3 centimetres.

"As a unit of Current, the International Ampère, which is one-tenth of the unit of current of the C. G. S. system of electro-magnetic units, and which is represented sufficiently well for practical use by the unvarying current which, when passed through a solution of nitrate of silver in water, and in accordance with the accompanying specification, deposits silver at the rate of 0.001118 grammes per second.

"As a unit of E. M. F., the International Volt, which is the E. M. F.

that, steadily applied to a conductor whose resistance is one international ohm, will produce a current of one international ampère, and which is represented sufficiently well for practical use by $\frac{1000}{1434}$ of the E. M. F. between the poles or electrodes of the voltaic cell known as Clark's cell, at a temperature of 15 degrees C., and prepared in the manner described in the accompanying specification.

"As the unit of Quantity, the International Coulomb, which is the quantity of electricity transferred by a current of one international ampère in one second.

"As the unit of Capacity, the International Farad, which is the capacity of a conductor charged to a potential of one international volt by one international coulomb of electricity.

"As the unit of Work, the Joule, which is 10^7 units of work in the C. G. S. system, and which is represented sufficiently well for practical use by the energy expended in one second by an international ampère in an international ohm.

"As the unit of Power, the International Watt, which is equal to 10^7 units of power in the C. G. S. system, and which is represented sufficiently well for practical use by the work done at the rate of one Joule per second.

"As the unit of Induction, the Henry, which is the induction in the circuit when the E. M. F. induced in this circuit is one international volt, while the inducing current varies at the rate of one international ampère per second."

In another portion of the magazine will be found some interesting remarks by Prof. S. P. Thompson with reference to the discussions which took place at the Chicago Congress in connection with this question.

TRANSFORMER PATENTS IN FRANCE.

A few months ago a decision on the Zipernowski system of electric distribution was rendered by the Cour d' Orléans (Appellate Court), which is of incidental if not direct interest, in view of litigation here.

The suit was based on the two French patents of 20th March, 1885, and 21st April, 1885, issued to Zipernowski and Déri, the first being for a disposition of transformers providing for the automatic and instantaneous regulation of the local circuits, so that the extinction of one or more lamps in such circuit shall have no influence on such as remain lighted, the second for a transformer with a closed magnetic circuit without poles. The question arose in connection with the use by the local lighting company of the City of Tours of certain apparatus alleged to infringe the Zipernowski-Déri patents, which were thereupon attacked on the usual grounds, the patents of Gramme (for a magnetically-closed core), Fuller, Rankin Kennedy, Gaulard, Varley, Hopkinson and others being referred to, other defences specifically applicable under the French patent law being also adduced.

The Court of Appeal, after having a detailed report from experts, held that the apparatus in question did infringe the Zipernowski patents, which were not invalidated by the alleged anticipations.

As a result of the whole case, the judgment of the lower court was reversed; the defendants were ordered to pay such damages as should be fixed by the report of an officer of the court; the infringing apparatus to be confiscated; and the defendants to pay costs.

TIVOLI–ROME.

The proposal (and the succeeding work carried on in pursuance thereof) to utilize the enormous water power of Niagara by electric means, naturally calls attention not only to the vast operations now nearly completed with that object in view, but also to similar enterprises with a like object.

Among the boldest and most successful of these has been the Tivoli-Rome installation, the generating station of which, on the site of the historic villa of Mæcenas, is about twenty-five kilometres (fifteen and a half miles) from the point of distribution in the Sacred City itself.

This plant, as is well known, is operated by water power, and, for the present purpose, a description of that portion of the installation may be omitted. Passing on to the strictly electrical part of the work, we find that the dynamos themselves are of the well-known Zipernowski type, manufactured by the firm of Ganz & Co. of Buda-Pesth. The speed is 170 *r. p. m.*, the pressure at this speed being 5,100 volts, and the current 42 ampères. The machines have 30 poles, and weigh some 12,000 kg. each, the efficiency (on full load we presume) being given as 93 1-2 per cent.

The exciters are four-pole machines, make 375 *r. p. m.*, and give 150 ampères at 180 volts.

The switchboard arrangements are most elaborate and complete, but space will not permit at present of a description of the various instruments, switching and regulating devices, safety appliances, and so on. We may at a later date give some interesting details on this subject, but for the present we pass on to the line construction.

The line passes across the malarial and sparsely-populated region known as the Campagna of Rome; except at one or two points there is small opportunity for injury to life or person, and at such points precautions are taken.

The uprights or poles for carrying the wires consist firstly of two iron members bolted together and set in the ground about 2 metres, in cement. The total length of this iron portion is about 8 metres. The upper portion of the pole is of oak, some 16x20 *cm.* in cross section; this is about 2.50 *m.* long, clear of the iron portion, and carries four brackets, of somewhat unusual but ingenious design, to support the four main high-tension conductors for the 5,000-volt circuit carried to the outskirts of the City of Rome. These brackets are placed about 60 *cm.* apart, and alternate, like the ordinary pole-step. Other and smaller brackets are provided for the purpose of carrying telegraph and telephone wires.

These main brackets much resemble the usual wall-bracket, but at the usual place of attachment to the pole a saddle or strap is extended around three sides of the pole, and on the back a cross piece and nuts adapted to the threaded ends of the saddle enable an absolutely firm and rigid support to be given to the bracket.

The insulator itself is of a light-brown porcelain, manufactured especially, the wire resting in a groove on the top. It is of the double petticoat type, the inner lips dipping into a saucer-like sub-insulator furnished with oil. This sub-insulator is not really intended to increase the insulation, but rather to act as what we might call here a "bug preventer"; in other words, the object is to prevent insects from building their nests in the lower part of the main insulator. This has been found an appreciable cause of trouble in some countries.

Each pole is constituted a lightning arrester in itself, by means of a metal cap and point on the top of the pole, connected by a conductor with the iron portion of the pole, which is thoroughly grounded. Each pole, as a rule, carries eight insulators and eight conductors, four for the main current, two for telegraph, and two for telephone.

The total height of the poles above ground is 9.50 *m.*, the distance between poles averages 35 *m.*, and the total number of poles is 707—nearly 50 poles to the mile.

The lowest of the four power-cables is 7.50 *m.* from the ground,

the next 8.10 *m.*, the next 8.70 *m.*, and the uppermost one 9.30 *m.* Nothwithstanding the fact that the lower portion of the pole is of iron and is "dead grounded," the insulation resistance is stated to amount to 3,250 megohms per mile.

The cables are composed of 19 strands of wire, each strand having a diameter of 2.6 millimetres, the conductivity being equal to that of copper, 99 per cent of chemically pure metal, and the resistance of each cable was found to be 3.75 ohms.

(To be continued.)

"*CUM PRIVILEGIO REGIS.*"

This familiar expression will remind many of our readers of the fact that the law of copyright, though perhaps less directly so than the law relating to patents, still derives its origin historically from the days when exclusive privileges and monopolies were granted by royalty as perquisites to its favorites, rather than, as at the present time, being considered a fair recompense from those who benefit by the efforts of leaders in the van of literary and industrial progress.

An interesting example of this is the following announcement prefixed to an old work, descriptive of various mechanical devices, written by Besson in 1569. It reads: "PRIVILEGE DU ROY. Par ample et special priuilege du Roy, donné à Maistre Iacques Besson, Autheur de ce present ouure, pour dis ans prochainement venans, commençant du iour que l'ouure sera achevé d'imprimer; defences sont faites à toutes personnes, de quelque qualité ou condition qu'ils soyent, de ne faire, contrefaire, graver, vendre, n'y à ce consentir: tant à la peinture qu'en la fabrique des Inventions contenues en ce present ouure, sans la permission dudit Autheur sur les peines contenues et specifieés audit priuilege. Donné à Orleans, l'an mil cinq cens soisanteneuf le vingt septième iour du Iuin. "Par le Roy en son conseil

"SIGNE BRULART."

ANOTHER CONDUIT RAILWAY SYSTEM.

These words are, it may be admitted, calculated to induce a smile on the faces of the initiated. So many schemes, some bred of honest ignorance or a superfluity of enthusiasm, others, we regret to say, the offspring of a desire to obtain the property of other people without due value received, have been promoted, to the pecuniary loss of a large number of people, that it is hard to obtain proper attention for any project of this kind. When, therefore, a proposition is made in good faith for the consideration of a system having in it, apparently, some of the elements of success, and certainly some novelty, it is entitled to a fair and impartial hearing, even if it is not entirely free from features open to criticism. More especially is this the case when the work has been entered upon not unadvisedly, but after study and consideration of the merits and defects of existing systems and past attempts.

It is, we believe, a fact that even now the storage battery systems of street traction are not claimed to be a commercial success, however meritorious and interesting scientifically. In addition to the insuperable difficulty that every additional transformation of energy involves an additional loss, there is also the inherent condition, be it defect or otherwise, that a storage battery car must carry several hundredweight of material, which not only has to be carried at the cost of so much energy, but which does not pay its individually small but collectively essential nickels for the privilege of being hauled.

Public opinion only sanctions the use of the trolley system in default of any better method. If some other system which will pay dividends can be devised, not having overbalancing objectionable features of another kind, the trolley will eventually have to go. If it will not *pay*, which is the final criterion, then, of course, *cadit questio*.

The sum of five cents for carrying a passenger, for all reasonable city distances, seems unalterably fixed, and the limit of carrying capacity of a car cannot be largely increased—in practice.

If, therefore, some plan can be devised which, without materially exceeding in cost that of either of the two systems named, will avoid their defects, it will have, without doubt, a large field before it.

In a paper recently read before the American Institute of Electrical Engineers, Mr. Albert Stetson gives a description of the plan proposed by himself and his associates. We will endeavor to condense a portion of this sufficiently to give a general understanding of the arrangement contemplated.

A conduit is used, similar to that of cable roads, but not nearly so large or expensive. In the slot of the conduit, attached to the car, runs a shoe extending nearly the length of the car. With the improved shoe, a conduit two or three inches wide and seven inches deep will answer perfectly, it is said.

The shoe is so supported that should the car leave the track it detaches itself immediately and remains on the top of the conduit. It cannot get caught, as the cable grip sometimes does, and drag the car along through crowded streets at a dangerous speed. The shoe is somewhat like a cigar in shape, so as not to give any sharp blow to the contact arms. The sides of the shoe are formed of conducting material, insulated from each other, and perfectly flexible, so as to follow any curves, and the shoe can be attached to and detached from a car in from five to ten seconds.

In the conduit are placed two insulated cables, a metallic return being used, and, in fact, regarded as necessary to ensure perfectly safe working. These cables run into and through contact-boxes placed at intervals of ten feet on each side, they being arranged diagonally opposite, so that the distance between the boxes is about five feet. The cable is carried into a box, and the lead covering and insulation removed for about two inches. On to this bared cable there is fastened a brass clamp with a projecting tongue.

The contact-making portion of the device is a vertical rod or spindle having at its upper end an arm projecting through a stuffing box into the conduit, and at its lower end a brush adapted to be

brought into contact with the tongue attached to the cable. This rod and its bearings must, of course, be properly insulated from the contact-box. When no car is passing, the brush is out of all electrical connection with the current conductor, but when the shoe on the car reaches the arm projecting into the conduit, it swings it to one side, bringing the brush on the rod into contact with the tongue fastened to the electrical conductor, and the current passes to the motor on the car. As soon as the shoe on the car has passed the box, a spring forces the rod back into its normal position, and that box is dead. The box is filled, so far as it can be without interfering with the movement of the brush, with suitable oil for insulation purposes. The spindle or rod, which at times becomes "alive," and its bearings are thoroughly insulated from all parts of the box and cable. The ends of the shoe attached to the car are made of insulating material, thereby establishing mechanical contact within the box before the metallic portion comes into contact with the arm, and also holding the inside contact after the current ceases to flow to the motor. This is considered an important feature, for the reason that without such an arrangement the brushes might soon burn out, the oil become carbonized, and the boxes useless.

It will naturally occur, in the first place, to any one acquainted with the subject, that the cost of some 1,000 contact boxes per mile, in addition to the complete metallic circuit contemplated, will add a considerable item of expense to the capital expenditure on construction, and also introduce probabilities of a numerous chapter of leaks to ground.

No doubt it would be contended with regard to the mere expense, that considering the doing away with the overhead circuit and the ground return wires, the latter now or soon to be entirely metallic, together with the question of maintenance, the difference in cost would not be so considerable as might at first appear. This may be a question open to some discussion, but as to the matter of insulation Mr. Stetson submitted the following report of a test made under trying conditions:

"NEW YORK, Sept. 21, 1893.

"*Albert Stetson, Esq., 50 Broadway, New York City:*

"DEAR SIR—In accordance with your request of yesterday, *in re* tests made by me on the new electric conduit and car at Coney Island, I beg to submit the following report:

"The insulation resitsance of the whole line, when car is not in circuit, equals 63,500 ohms.

"The insulation resistance of line, with shoe of car and adjacent switch boxes in contact with shoe submerged in water, equals 380 ohms.

"Electro-motive force of power circuit equals 353 volts; 353÷380 =.926 ampère loss.

"Seventy-five feet of conduit were pumped up full of water previous to the test.

"With Weston ammeter the reading was hardly discernible.

"The loss on boxes tested by Weston voltmeter showed nothing.

"The resistance test was made with Thomson tripod galvanometer, and by comparison with standard resistances.

"From the above figures the following result is arrived at:

"As 75 feet of the conduit were submerged, this would include 12 boxes. Therefore, it is safe to assume that the loss was only on those boxes, as several of the dry boxes tested showed no leakage.

"Then, as the loss on the circuit with boxes all open (that is, electrically) was .0058 ampères, equalling .0027 horse-power, the loss on each box equals $\frac{1}{12}$, which amounts to .000483 ampères, and which equals .000223 horse-power. It therefore would take 4,484 boxes entirely submerged to give a loss of 2.113 ampères or one horse-power, and, as the boxes are six feet apart, this equals 5.092 miles.

"The car standing with shoe entirely submerged, and the two adjacent boxes with the switches turned on, showed a loss of .926 ampères, equalling .438 horse-power. And, as the car takes about 12 ampères, this equals 5.68 horse-power on ordinary track. This shows that it loses 7.96 per cent of its power when so placed; or, expressed

differently, 13 cars placed in the same condition would lose about the same amount of power which it takes to drive one car.

[Signed] "E. W. STEVENSON,
"Electrician, Brush Illuminating Company."

With regard to this test, such examination as may have been made at a time when the system was not in operation, though interesting, is not so material as that showing "the insulation resistance of line, with shoe of car and adjacent switch-boxes in contact with shoe submerged in water." This was only 380 ohms, and as in practice the voltage would be the standard voltage of 500 v., not 353 v., the leakage would be 1.31 ampères, or .878 horse-power for each car in operation. The general leak throughout the system when cars are not in operation would appear at first sight small, but the ratio of the length of Mr. Stetson's experimental road to the length of an actual city road, with its ramifications, when inverted and applied to the 63,500 ohms mentioned, would, we fear, bring the insulation resistance undesirably low.

The question of *repairs* to a number of contact boxes, say 900 to 1,000 a mile, is one which will be a matter of most serious consideration, especially if every trifling repair involves the disinterment of a section of conduit, and its re-burial. It is inconceivable that some thousands of switches, operated every few minutes, and situated, as these will be, in as objectionable a place as could well be selected, will not require attention. In addition to the cost of this work the interruption to the service in case of derangement is perhaps even a more disagreeable contingency to contemplate.

It should further be remembered that tests and figures obtained, however honestly and with the desire of arriving at actual facts, are always illusory as compared with the results of actual service under conditions varying in their nature and impossible to be foreseen.

With regard to the cables themselves, the necessity for the very highest and most expensive grade of insulation is at once apparent. They will confessedly be subjected to the most trying conditions, con-

ditions practically as severe as for submarine work, with the exception of abrasion, but with the added trouble of chemical action from street sewage. This is not the condition of a carefully built and comparatively dry subway, nor that of wires suspended at intervals on glass insulators. An incipient leak, due to some slight oversight in manufacture or carelessness of workmen, will certainly get no *better*, and the "circus" arising from a short circuit in the conduit can be better imagined than described.

Mr. Stetson evidently appreciates the difficulty of the problem, and is not a mere theorist. He says: "We have not attempted to make a road operative in fine weather, and under ideal conditions; but have known that to ensure success we must take the streets as we find them. They will get muddy, rain will fall, and snow will come, and if a slotted conduit road is to succeed it must work undisturbed by them." This is most true, and without the least disparagement of his ingenious efforts we think he is unduly sanguine *now*, when he "asserts with the utmost confidence that he has succeeded." It may be that he is on the road to success, but we may fairly doubt whether he has yet arrived at the goal.

The heavy cost of installation, the liability to troublesome and expensive repairs, and consequent interruption of service, the difficulty of preserving the high insulation required, and, perhaps, minor mechanical troubles with the shoe and contact-devices are matters which it seems to us will require further elaboration before the system can be pronounced an established success.

EDITORIAL NOTES.

M. Hospitalier, in a recent number of *L'Industrie Electrique*, after briefly describing Mr. Tesla's oscillator, and referring to his address on the subject at the Chicago congress, closes by saying: "The experiments of Mr. Tesla are still too rudimentary to enable us to foresee the practical future reserved for them, but the enthusiasm and confidence of the inventor are so infectious, and his personality so sympathetic, that the plaudits of the distinguished audience to whom he was speaking discounted the future, and decided the question against those of more conservative views." This might serve as the text for a valuable lay sermon on the distinction between *credulity* and *faith*. This distinction is a real and material one, as many have found who have been led away by the glib assurances of some ignorant charlatan, to the depletion of their purses. Even now, at the end of the 19th century, the wolf seeking the foolish lamb is still with us.

These are mere quacks, a reliance on whose pretensions is simple credulity; their names are fairly well known *now;* in ten years they will be forgotten. Tesla and the men of honored names, of whom he is perhaps the youngest and most enthusiastic example, would scorn followers and comrades of the electric-belt and primary-battery-scheme class.

Faith is a reasonable assurance that we are on the track leading to the truth, and that by hard work we shall arrive at it. Credulity is an unreasonable assurance that we "know it all," or that, if we do not know it all, that the portion left is of too insignificant proportions to be considered.

The antithesis is analogous to that existing between the respective attitudes of mind of the modest and intelligent truth-seeker, and of the blatant and self-sufficient humbug.

There appears to be a widely-spread idea that the system of awards at the World's Fair has not resulted in a manner satisfactory either to exhibitors or the public, and that awards and certificates of excellence have been so lavishly and indiscriminately distributed that it is rather a distinction *not* to have received one.

This is not entirely an unfounded charge, and does not apply specially or merely to the electrical branch; but referring to that alone, it is easy to see how very valuable thorough and unbiassed reports by competent judges might be. It is to be presumed that the conditions did not permit, but had it been possible, how useful and interesting would have been reliable data on the apparatus of some of the foremost manufacturers of the world. Take, for example, the question of dynamos, and suppose the judges had tested and reported on the quality and quantity of iron, its degree of saturation, the sizes of conductors, the output in watts for a given weight, the speed of revolution, the current density in field and armature, the heating, the regulation, and many other subjects; or, in connection with storage batteries, the material and construction of the plates, the composition and density of the solution, the behavior of the cells under extremes of temperature or rough usage, the *life* of the cells, their first cost and cost of maintenance. Under the conditious which actually obtained, this was no doubt impracticable, but at the same time it may well be regretted that some arrangement could not have been made by which both the exhibitor and the public would have been furnished with a little more information than that afforded by the very general terms of the present commendatory awards.

It is not surprising that, after the long and bitter litigation in connection with the Edison incandescent lamp patent, resulting in substantial victory for the Edison interests, there should be attempts made in the direction of evading or avoiding that patent. Whether or no these efforts are successful or justifiable will be decided by the proper tribunals. It is clear, however, that the anti-Edison contingent will

die hard, if die they must, and that all interest in the fight is by no means extinct. In Cleveland, in Boston, and in Connecticut, proceedings are still pending in injunctions beside those on final hearing elsewhere. In the de Khotinsky case in Boston the court was of the opinion that the introduction into the bulb of a certain amount of inert gas did not avoid the substantial employment of the vacuum claimed by Mr. Edison.

The text of Judge Colt's opinion in the de Khotinsky case is as follows: "The defendants do not disclose by their affidavits the kind or the amount of vapor which is inserted in the glass bulb of their lamp. From all that appears, therefore, the defendants' lamp has the vacuum called for by the Edison patent, although it may contain in addition a small amount of some kind of gas or vapor.

"Under these circumstances it would be improper for the court to enter further into the consideration of the question sought to be raised by this motion.

"As the proof stands, I am of opinion that the defendants' lamp contains all the elements set forth in the second claim of the Edison patent. Motion granted."

In the "Novak" case in Connecticut the same position appears to have been taken by the court. In the course of his decision in that case, Judge Shipman made use of the following expressions: "In view of the present condition of incandescent lighting in this country, I have no doubt that an Edison lamp with the exhaustion which was given in the experiments would be considered by the users of electric light as so far inferior to the ordinary standard of an Edison lamp as to be worthless, and would be discarded by those who were accustomed to the usual stability of an incandescent lamp. But these experiments show to my mind, when read in connection with the other affidavits of the defendants, that Waring intentionally used the principle of exhaustion to a generous degree, and that the vacuum ingredient of Edison was, to a large extent, employed and its benefits were partially enjoyed. Waring took the lamp which Edison gave in

1880, and which was the first practical incandescent electric light, and used all the ideas which were finally embodied in the Edison lamp, but used the idea of exhaustion to a more limited extent than the original inventor thought was necessary; nevertheless, without the large exhaustion of the atmospheric air and the gases which Waring accomplished, his lamp would be a failure. It will not be claimed that the inventor of an improvement upon a previously patented combination can use one of the patented elements in a dwarfed and incomplete way, but by its use receive the old resultant benefit, and escape the charge of infringement by reason of the low percentage of such use. The defendants' theory is that its use is so far unlike that of Edison that it can properly be said to be radically different. That theory is not supported in the Waring specification, and it does not seem to me to be supported by the facts. The statement in the specification that the atmospheric air may be at first exhausted as nearly as possible, and the desired gas then admitted, is significant."

By direction of the judge, however, the proceedings were held in suspense, and when the case was again called the court announced from the bench that there was considerable doubt in his mind as to whether his opinion would be confirmed by the Court of Appeals. There were a number of new features in the case, and several delicate questions to be considered, as to the merits of which he was not sufficiently positive to warrant him in granting an injunction, and consequently he refused to do so. He therefore left the matter subject to the decision of the Court of Appeals, and allowed the Waring Company to continue the manufacture and sale of their lamps under $10,000 bonds.

A new point arose in the Davis case. This was whether the opening of the bulb at the top, the removal of a burnt-out filament, its substitution by a new one, and the subsequent exhaustion and sealing of the bulb is a mere *repair*, or virtually the construction of a new lamp. The United States Circuit Court issued an injunction restraining the work, and the matter then went to the Appellate Court, in whose hands it still remains.

And now comes the decision of Judge Ricks, at Cleveland, that the Edison Company is not to be permitted to "go back" on their own limitation of their own patent, such limitation having been made apparently with deliberation and with the intent to prevent the patent being void *ab initio* by the operation of that seemingly unintelligible section providing for the limitation of United States patents by reason of foreign patents. According to this the Edison patent has already expired, but we presume the Edison company will have something to say on that question. "It is a very pretty quarrel, as it stands."

John Tyndall is dead. He died on the 4th December, at Haslemere, Surrey, his age being 73 years.

He was born at Leighlin Bridge, County Carlow, Ireland, in August, 1820. He was educated in the local schools, and in 1839 joined the Irish Ordnance Survey, where he acquired valuable practical knowledge as a draughtsman, computer, surveyor, and trigonometrical observer, after which he was a railroad engineer for some three years. In 1848 he began the original researches which, continuing for forty years, made him one of the foremost men of science of his day. Attracted by the fame of Prof. Bunsen, he went to the University of Marburg in Hesse-Cassel, and received his degree in 1851.

In June, 1853, having in the meantime returned to England and been elected a fellow of the Royal Society, he was appointed professor of natural philosphy at the Royal Institution, and this post he held until 1887.

Any comprehensive account of his works would practically be a history of science for the past thirty years. His reseaches into the questions relating to the constitution of light and spectral analysis, his alpine studies, his "Heat as a Mode of Motion," his lectures on electricity and magnetism in the early stages of the science, his researches into the phenomena of sound, and his work on the germ theory will be recalled by our readers.

In 1892 Prof. Tyndall visited America, and realized quite a large

sum from lectures which he delivered. He generously devoted the net proceeds of this tour to the founding of scholarships in science in Harvard, Columbia, and the University of Pennsylvania, "in aid of students who devote themselves to original research." We may, therefore, recognize in Tyndall one of the truest friends of the nation, bestowing upon our youth the whole proceeds of his educational tour as lecturer. The honors conferred on him have been very numerous, and his writings have appeared in constant succession for over thirty years.

In Tyndall we lose a conscientious and earnest laborer in the field, also so assiduously tilled by Agassiz, Huxley, Darwin, and others. *Requiescat in pace.*

We observe in a recent issue of the Boston *Transcript* the following notice of Mr. Goebel, whose recent claims to be the "inventor of the incandescent electric lamp" are familiar to our readers:

Henry Goebel, who, it is said, invented the incandescent electric lamp, died last Monday, in New York. Mr. Goebel was born on April 20th, 1818, at Springer, a small village in Hanover, Germany. Goebel took up the trade of a watchmaker and optician. He invented many new devices in the mechanism of clocks and watches, and experimented with lenses and optical instruments of his own construction. Later he became interested in electricity. He arrived in New York Feb. 2, 1849. In 1850 he began extensive experimenting with incandescent lights. His first lamps were constructed out of empty cologne bottles, with thick wire inside. As that did not give satisfactory results a thin copper wire was substituted, and Mr. Goebel only succeeded in heating the wire to a redness, due to imperfect vacuum, in the cologne bottles. To overcome it he invented a mercury pump. The wire filament worked badly and he searched for a substitute. One day, in burning out the wood from the ferrule of a cane, he noticed that portions which had been excluded from the air turned into almost pure carbon when heated. It was this that suggested to him the use of a carbonized fibre of wood in place of the metallic thread. Shaving off some strips from the reed stem of his pipe, he carbonized them and placed them in a lamp. They gave an excellent light, but were apt to break by exhaustion or contraction due to changes of temperature. From that he evolved the idea of making them in the shape of horseshoes or hairpins, whereby they admitted of considerable expansion or contraction without breaking.

The *Electrical Review*, in referring to Goebel's work, says:

Before the war, Goebel built a large telescope and mounted it on a wagon, taking it out on the streets at night and charging a fee to look at the stars. He had batteries in the wagon, and a number of his incandescent lamps were mounted on a frame near

the seat. When the business was dull he would light the lamps and thus attract a crowd. In 1881 a company was organized in this city (New York) to make electric lamps. Goebel was taken into the company, which later became financially involved, and failed. In the many recent suits brought by the Edison Electric Light Company against alleged infringing manufacturers of incandescent lamps, Goebel's testimony has been of great value to the defence, especially in the cases of the Beacon Vacuum Pump and Electrical Company of Boston and the Columbia Incandescent Lamp Company of St. Louis. Final decisions in these cases have not yet (December, 1893) been reached, although the Columbia Company won in the suit for a temporary injunction on the Goebel testimony.

In connection with the distribution of electric light by alternating currents and transformers we are often told, and without question correctly so, that in arriving at the output or work at the central station the product of the volts into the ampères does not give a true representation of the actual work in watts, horse-power, or whatever unit may be selected, and we have thrust before our nose square roots of average squares and cosines of angle of lag and co-efficients of induction, until the average station superintendent feels his brain reel. With all the necessary data and the required experience and knowledge and the best instruments obtainable, it is a somewhat delicate and troublesome operation to arrive at the correct output for the indications afforded, say, by a Cardew voltmeter and a Siemens electrodynamometer. Would it not be possible for "one in authority" to furnish to the public an approximation for rough purposes as to *how far wrong* the product of the indications of current and *e. m. f.*, as given by the instruments named, would be, making the following assumptions: A dynamo giving 16,500 alternations per second, the curve being a pure sine curve; any commercial converter used in the United States; assume an efficiency of 95 per cent on full load, and a leak on open secondary of 0.075 ampère for a 2.5 kilowatt converter; a ratio of conversion of 1 :20, and an initial voltage at the station of 1,100 volts on full load? First, with twenty-five such converters connected as to their primaries, but no translating devices in the secondaries; second, with a full load, and third, with half load. In what ratio or percentage would the indications, as given by the above instruments under the three conditions, vary from the truth?

LIST OF ELECTRICAL PATENTS ISSUED DURING THE PAST MONTH.

1893, DEC. 5TH. OFFICIAL GAZETTE, NO. 10.

509,873. Signalling telegraph. Michael J. Burns, Lowell, Mass., assignor to Gamewell Fire Alarm Telegraph Co., New York.

509,932. Testing apparatus for multiple switch boards. Frank R. McBerty, Downer's Grove, assignor to the Western Electric Co., Chicago, Ill.

509,953 and 509,955. Regulators for dynamo-electric machines. 509,954. Dynamo-electric machine. 509,956. Annunciator for telephone switch boards. Charles E. Scribner, Chicago, Ill., assignor to Western Electric Co.

509,964. Telegraph key. Josef Steiner, Brooklyn, N. Y., assignor to Western Electric Co., Chicago.

509,965. Telephonic transmission. John S. Stone, Boston, Mass., assignor to American Bell Telephone Co.

510,002, 510,003, 510,004, 510,005, 510,006, 510,007. Telegraphy. Patrick B. Delany, South Orange, N. J.

510,018. Incandescent electric lamp. H. Green, Hartford, Conn.

510,048. Electrical apparatus for operating dental implements. O. H. Pieper, San Jose, Cal.

510,059. Electric motor. Arthur A. Beard, Manchester, Ala.

510,061. Conduit electric railway. Wm. R. De Voe, Shreveport, La., assignor of part to C. W. Dawley and Patrick B. Cash.

510,074. Electrical measuring instrument. Otto T. Louis, Philadelphia.

510,095. Shade for electric lamp. Geo. F. Seavey, Boston, Mass.

510,102. Electric motor or dynamo. Herman K. Thiel, Alpena, Mich.

510,115. Electric fire alarm. Milton C. Cantrell, Springfield, Mo.

510,142. Conduit railway trolley. Paul C. Just, Chicago.

510,177. Combined ammeter and voltmeter. Edw. W. Jewell, Wheaton, Ill.

510,188. Electric lighting system. Geo. B. Pennock, Chicago.

510,195. Automatic telephone exchange system. John Serdinko, New Braunfels, Tex.

510,201. Trolley and trolley switch. David V. B. Smart, Troy, N. Y.

510,209. Electric telegraphy. Charles Thom, Jr., Brooklyn, N. Y.

510,217. Support for trolley wires. James E. Walker, Denver, Colo.

510,260. Electric arc lighting system. Daniel Higham, Boston.

510,276. Process of electrolytically decomposing fused metallic chlorides. Farnham M. Lyte, London, Eng.

510,317. Bracket for incandescent lamps. Charles M. Berry, San Francisco, assignor to E. D. Middlekauff.

510,320. Magneto apparatus. Arthur F. Boardman, Somerville, assignor of part to John Tyler Hicks, Boston.

510,367. Reciprocating electric motors. Arthur R. Roe, Duluth, Minn., assignor to Electric Motor Co.

510,384. Electrically-operated railway switch. Henry L. Falco, Brooklyn, N. Y.

DEC. 12TH. OFFICIAL GAZETTE, NO. 11.

510,430. Telegraph or telephone system. Wallace R. Kirk, Kansas City, Mo.

510,457. Electric call system. Samuel Whitehall, South Bend, and Euphrates W. Whitehall, Attica, Ind.

510,460. Dynamo-electric machine. David H. Wilson, Chicago.

510,465. Regulator for dynamo-electric machines. Louis Bell, Boston, Mass., assignor to General Electric Co.

510,466. Electric fan. Edward H. Bennett, Jr., Bayonne, N. J.

510,467. Magnetic nail driver. Reinhold Boeklen, Brooklyn, N. Y.

510,469. Cable tramway. Wm. W. Colan, London, Eng.

510,472. Dynamo electric machine. Rudolf Eickemeyer, Yonkers, N. Y.

510,485. Trolley wire support. Leroy S. Pfouts, Canton, O.

510,486. Electric lamp support. James J. Renchau, New Britain, Conn.

510,487. System of electric distribution. E. W. Rice, Jr., Swampscott, assignor to General Electric Co.

510,508. Simultaneous telegraphy and telephony. Silas W. Holman, Boston, Mass.

510,533. Electric switch. Jacobs S. Gibbs, Hartford, Conn., assignor to Perkins Electric Switch Manufacturing Co.

510,534. Rotary current motor. Johannes H. F. Gorges, Berlin, Germany, assignor to Seimens & Halske.

510,535. Telephone toll apparatus. Wm. Gray, Hartford, Conn., assignor of part to Charles Soby.

510,596. Reversing switch for electric motors. John G. Germann, Erie, Pa.

510,600. Speed-reducing and power-multiplying hydraulic gear for electric railroad cars. William Hochhausen, Brooklyn, N. Y.

510,601. Alternating current motor. William Hochhausen, Brooklyn, N. Y.

510,602. Dynamo electric regulator for engine driving generator. Rudolph M. Hunter, Philadelphia, Pa., assignor to Thomson-Houston Electric Co.

510,603. Power-applying device for electric motors. Arthur H. Johnson, Rahway, N. J., assignor to Hall Signal Co.

510,604. Electric battery. Louis F. Johnson, Poughkeepsie, N. Y.

510,605. Electric arc lamp. Jesse K. Kester, La Grange, Ill., assignor to F. P. Little Electrical Construction and Supply Co., Buffalo.

510,612. System of telegraphy.

510,613. Magneto-electric induction apparatus. Charles J. Reed, Orange, N. J., assignor of part to Gustav Stahl, Philadelphia.

510,634. Electric railway conduit. Wm. R. DeVoe, Shreveport, La.

510,640. Electric current transformer. Wm. H. Hornberger, Elkhart, Ind.

510,646. Automatic circuit controller. Charles L. Mayhew, Saratoga Springs, N. Y.

510,647. Conduit electric railway. John P. Mitchell, San Francisco, Cal.

510,661. Electric car truck. Charles F. Winkler, Troy, N. Y.

510,662. Electric motor. Charles F. Winkler, Troy, N. Y.

510,777. Apparatus for heating metals electrically. C. L. Coffin, Detroit, Mich.

510,808. Machine for making storage battery grids. Robt. M. Lloyd, New York.

510,809. Insulator pin. Fred. M. Locke, Victor, assignor of part to George A. Paddock, Auburn, and Willard C. Page, Palmyra, N. Y.

510,850. Closed-circuit system for electric railways. Robert H. Elliott, Birmingham, Ala.

510,862. Regulating parallel-circuited alternate current machines. Carl Hoffmann, Berlin, Germany.

510,863. Telephone exchange system. Wm. M. Jacques, Newton, assignor to American Bell Telephone Co.

RE-ISSUE.

11,395. Electric snap switch. Gerald W. Hart, assignor to Hart & Hegeman Manufacturing Co., Hartford, Conn.

DEC. 19. OFFICIAL GAZETTE, NO. 12.

510,889. Temperature-regulator for electric heaters. Albert M. Betz, Oak Park, Ill.

510,898. Electrical connector. Frank G. Curtiss, New York.

510,899. Method of adjusting the joints of carbon electrodes.

510,900. Apparatus for electrolytically producing soda and chlorine.

510,901 and 510,902. Electrode for voltaic cells. Elisha B. Cutter, New York.

510,921. Electric pump. Frank W. Merritt, Duluth, Minn., assignor to Electric Motor Co., Duluth.

510,929. System of telegraphy. Josiah A. Parker, St. Louis, Mo., and Leland L. Summers, Chicago.

510,932. Electric elevator. Frank A. Perrett, Brooklyn, N. Y., assignor to Elektron Manufacturing Co., New York.

510,947. Electric locomotive. Charles F. Winkler, Troy, N. Y., assignor to United Columbia Electric Co.

510,952. Brush holder for dynamo electric machines. Frank E. Averill, Syracuse, N. Y.

511,005. Telegraphic relay. Edward Weston, Newark, N. J.

511,017. Electric railway switch and crossing. 511,018, 511,019, electric railway trolley. Wm. W. Hendrix, Bowling Green, Ky.

511,049. Electric arc lamp. August Hownel and George S. Junginger, New York.

511,081. Telautograph. Rudolph M. Hunter, Philadelphia.

511,118. Magneto-telephone. James A. Brown, Moline, Ill.

511,131. Electric railway signal. Jose Ortego Y Espinosa, Mexico.

511,157. Hand regulator for electric motors. Wm. D. Packard, Warren, O.

511,159. Primary electric battery. Edward Poppowitsch, Brooklyn, assignor of part to Herman Wustenfeld, New York.

511,163. Signal for cable railways. Joseph Sachs, New York.

511,172. Telegraphic transmitter. Mary E. Stinde, Red Bud, Ill.

511,173. Electrically-operated railway switch. Chas. A. Stone and Edwin S. Webster, Boston, Mass.

511,187. Electric regulating switch. Edward A. Barber, Watertown, Ky.

511,188. Electric signalling device for hose. Geo. S. Barnard, Milwaukee, Wis.

511,196. Electric motor. Oliver P. Conklin, Dayton, O., assignor to the Dayton Fan and Motor Co.

511,214. Brush holders for electric motors. James J. Robinson and Fred B. Perkins, Toledo, O.

511,229. Electric lamp. Albert Zobel, Munich, Germany.

511,234. Morse transmitter. Albert F. M. Cornand, Brussels, Belgium, assignor of part to W. T. Barnard, New York.

511,240. Electric switch. Jesse L. Hinds, Syracuse, N. Y., assignor to Electric Engineering and Supply Co.

511,244. Telegraphic relay. Frank P. Medina, San Francisco, Cal.

511,245. Thermo-electric element. Max Mestern, Turin, Italy, assignor to Thermo-Electric Co., West Virginia.

511,254. Closed conduit electric railway. William S. Smith, Berkeley, Cal.

511,259. Rheostat. Franklin A. Weller, Boston.

511,276. Two station telephone circuit. Frank A. Pickernell, Newark, N. J.

511,286. Resistance box. Adelbert O. Benecke, Newark, N. J.

511,289. Power-transmitting and speed-regulating mechanism. Wm. Cooper and George P. Hampton, Minneapolis, Minn., assignors to Cooper-Hampton Electric Co.

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511,328. Method of electric commutation and a fluid electric commutator. Charles E. Emery, Brooklyn, N. Y.

511,242. Conduit-railway trolley. John C. Love, Chicago, assignor to Love Electric Traction Co.

511,343. Trolley for conduit railways. John C. Love, Chicago, assignor to Love Electric Traction Co.

511,344. Support for electric conductors. John C. Love, Philadelphia, Pa., assignor to Love Electric Traction Co.

511,345. Tension device for electric conductors. John C. Love, Philadelphia, Pa., assignor to Love Electric Traction Co.

511,346. Trolley-bar carrier for cars. John C. Love, Philadelphia, Pa., assignor to Love Electric Traction Co.

511,347. Governor for electric motors. John Marty, Jr., Cleveland, O.

511,358. Telephone. Barton Pickering, Dayton, O.

511,375. Method of and means for compounding dynamo-electric machines. Elihu Thomson, Swampscott, Mass., assignor to General Electric Co.

511,376. Electric measuring instrument. Elihu Thomson, Swampscott, assignor to General Electric Co.

511,401. Electric meter. Lucien Brille, Paris, France.

511,419. Trolley-wire crossing. Henry Geise, Philadelphia, Pa., assignor of part to Edwin Jaquett Sellers and Horace Pettit.

511,434. Galvanic battery. Harry T. Johnson, New York, N. Y.

511,448. Electric locomotive. John G. McCormick, Louisville, Ky.

511,451. Electric bell. Augustus J. Oehring, Chicago, assignor to Western Electric Co.

511,452. Conduit for electric railways. Henry D. Oler, Paterson, N. J.

511,456. Telephonic instrument. Parnell Rabbidge, Sydney, New South Wales.

511,459. Carbonizing apparatus. Isaiah L. Roberts, Brooklyn, N. Y.

511,461. Safety device for electric circuits. Charles H. Rudd, Evanston, assignor to Western Electric Co.

511,462. Fire alarm telegraph. Charles H. Rudd, Chicago, Ill., assignor to Western Electric Co.

511,464. Multiple-switchboard system for telephone-exchanges. Charles E. Scribner, Chicago, Ill., assignor to Western Electric Co.

511,495. Electric arc lamp. Reginald Belfield, London, Eng., assignor to George Westinghouse, Jr.

511,503. Electric measuring apparatus. Theodor Bruger, Bockenheim, near Frankfort-on-the-Main, Germany, assignor to Hartmann & Braun.

511,512. Machine for separating magnetic from non-magnetic substances. George G. Crosby, New York, N. Y., assignor to Magnetic Iron Milling Co., Tennessee.

511,514. Process of and composition for the manufacture of porous cups for electrical batteries. Frank G. Curtis, Philadelphia, Pa.

511,523. Current regulator for dynamo-electric machines. Charles D. Haskins, Brooklyn, N. Y., assignor to Western Electric Co.

511,524. Converter system for electric railways. Gustaf E. Hesse, Brooklyn, N. Y., assignor of part to William W. Share and Valdemar F. Lassoe.

511,527. Automatic electric light extinguisher. George M. Hughes and George T. Reed, Baltimore, Md., assignors to Automatic Electric Light Extinguisher Co., Baltimore.

511,547. Electric wire covering. Franklin S. Randall, Philadelphia, Pa.

511,559. Electrical transmission of power. Nikola Tesla, New York, N. Y., assignor to Tesla Electric Co.

511,560. System of electrical power transmission. Nikola Tesla, New York, N. Y., assignor to Tesla Electric Co.

511,570. Rotary electro-magnetic engine. Henry P. White, Kalamazoo, Mich.

511,574. Electric transformer. James J. Wood, Fort Wayne, Ind.

511,589. Telephone system. Frank R. Colvin, New York, N. Y.

511,739. Telephone system. John J. McNally, California, Mo.

511,611. Insulator. Charles N. Hammond, Boston, Mass., assignor to Hammond Cleat and Insulator Co.

511,612. Insulator. Charles N. Hammond, Boston, Mass., assignor to Hammond Cleat and Insulator Co.

511,613. Rosette for electric lights. Charles N. Hammond, Boston, Mass., assignor to Hammond Cleat and Insulator Co.

511,621. Electric motor apparatus. William A. Johnston, Arthur W. Browne and John C. Davidson, Prince's Bay, N. Y., assignors to S. S. White Dental Manufacturing Co.

511,627. Electric railway switching mechanism. Charles J. Kintner, New York, N. Y.

511,634. Trolley base. James L. Mauldin, Cleveland, O., assignor of part to Frank J. Lewis.

511,647. Electric grain-weighing scale. John Outcalt and David De P. A. Outcalt, Spotswood, N. J.

511,682. Electrolyzing apparatus. Antoine J. O. Chalandre, Paris, France, assignor to Society Outhenin Chalandre Fils et Cie.

511,731. Electric signalling apparatus. Thomas B. Doolittle, Bridgeport, Conn.

511,739. Telephone system. John J. McNally, California, Mo.

511,742. Electric cautery apparatus. James A. Wotton and Earnest A. Bostrom, Atlanta, Ga.

"SCRAP."

There are two things which will make us happy in this life, if we attend to them. The first is, never to vex ourselves about what we cannot help; and the second, never to vex ourselves about what we can help.

John Delfino, a murderer, was electrocuted at the Sing Sing (N. Y.) prison, on Dec. 4th. The current of 1,760 measured volts and six and one-half ampères was shot into Delfino's body at full strength for four seconds, and then was reduced to 1,600 volts, at which it was kept for 46 more seconds, when it was shut off. From under the cap that was fitted to the man's skull there came a slight whiff of steam when the current was turned on and passed through the dampened sponge, but aside from this and the stiffening of the man's body against the straps that held him by the head, body, hands and feet to the chair, it is said that there was no sign of violence in the execution.—*Electrical Review, N. Y.*

The London, Brighton & South Coast railway of England has thirty of its trains lighted by electricity, and is now about to equip a number of additional trains. It is said that about 15 per cent more work can be got out of an electrically-lighted than out of a gas-lighted train, which makes a saving in first cost of about $225,000, as eighty-five electrically-lighted trains can do the work of one hundred gas-lighted trains.

In a recent note to the French Academy of Science, M. F. F. Le Roux gives an interesting account of experiments which he has made to demonstrate the fact that the electro-motive force of an iron-copper contact is inverted at a high temperature. From these experiments he is led to conclude that towards the temperature of 1000 deg. cent. a

current going from the copper to the iron heats the junction, whilst at the ordinary temperature it cools the junction. Thus, for the first time we have experimental proof of the change of sign of the function of the temperature which the electro-motive force of contact between two metals represents. The fact is interesting both in a thermo-electric and a chemical sense.—*Engineering.*

The following paragraph has been going the round of the papers, and, although no longer quite new, is too good to miss:

"As near to recreation as anything of the kind ever engages the earnest attention of Prof. Elihu Thomson, is the interest which he shows in the alleged applications of electricity, particularly in regard to the devices by which the unscrupulous play upon the credulous and the suffering. While at the Chicago Fair he examined at a selling stand a so-called electrical appliance to be worn in the shoes, for the cure of various ailments from cold feet upwards. The young woman volubly described the apparatus, in political phrase, 'claiming everything,' and then proceeded to explain the 'scientific principles' by which the electric current would pass up one limb to the heart and then down by the other one, and much more of the like. The professor mildly stated that electricity did not operate in the manner stated, when the young woman swept the goods back into the show case, indignantly exclaiming, 'Well, what do *you* know about electricity, anyway?'"

A Racine man ordered from a Chicago firm, with other books, a copy of Canon Farrar's book, "Seekers after God," then just out. In a short time the other volumes came to hand, but being out of the Canon's book, the firm wrote at the bottom of the invoice: "No seekers after God in Chicago."

"One on Boston"—The following appeared in a Boston daily paper a few weeks ago: "Amateur winders wanted. Apply in person at ——— & Co." These must be needed for the "dynamite" machines we hear so much about.

He—"You don't mean to tell me you are going to marry that old bald-headed professor?" She—"He is rather bald, but think how many *young men of to-day are bald on the inside of their heads.*"

First Artist—"I received a magnificent tribute to my skill the other day at the exhibition."

Second Artist—"What was it?"

First Artist—"You know my picture 'A Storm at Sea?' Well, a man and his wife were looking at it, and I heard the man say, 'Come on, my dear, that picture makes me sick.'"—*Brooklyn Life.*

Gov. Brough was once matched against Corwin, and, in the midst of his speech, said:

"Gentlemen, my honored opponent himself, while he preaches advocacy of home industry, has a carriage at home which he got in England—had it shipped across the ocean to him. How is that for supporting home industry and labor?"

When Corwin came on the stand, he made a great show of embarrassment, stammered, and began slowly:

"Well, gentlemen, you have heard what my friend Mr. Brough has to say of my carriage. I plead guilty to the charges, and have only two things to say in my defence. The first is that the carriage came to me from an English ancestor as an heirloom, and I had to take it. Again, I have not used it for seven years, and it has been standing in my back yard all that time, and the chickens have converted it into a roost. Now, gentlemen," with a steady look at Brough, "I have nothing further to say in my defence, but I would like to know how Brough knows anything about my carriage if he has not been visiting my chicken-roost?"

CHANGE OF NAME

The Star Electric Lamp Company, Chicago, manufacturer of the Sunbeam Lamp, has changed its name to THE SUNBEAM LAMP MANUFACTURING COMPANY. The policy of this company is to furnish Lamps superior in quality. Recently some discoveries have been made as the result of the extensive experiments it has carried on, which it is claimed will greatly improve the quality and add to the value of the Lamp. Mr. F. S. TERRY, long and favorably known in connection with the Electrical Supply Company and the Ansonia Company, is now the Secretary of the new Company.

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